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APPARATUS AND METHOD FOR TREATMENT OF FOODSTUFFS  
WITH A GASEOUS MEDIUM FOR PROCESSING AND  
SUBSEQUENT DRYING

FIELD OF THE INVENTION

The present invention relates to an apparatus and a method for treatment of foodstuffs with water vapour for processing and subsequent drying.

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BACKGROUND ART

In food technology there are a very large number of apparatus for processing of products, primarily foodstuffs, by conditioned air or water vapour. Processing may relate to, for instance, freezing, cooling, heating, drying or boiling.

10 An endless conveyor belt is known from Applicant's own US 3,398,651. The conveyor belt is arranged to form along part of its extent a helical path, in which the conveyor belt forms a number of successive turns. The conveyor belt is made up of a great number of links which are designed so that the links in a first turn in the stack carry a subsequent second turn in the stack. This means that the conveyor belt is self-stacking. Conveyor belts of this type are advantageous since in a very limited space they can offer a long conveying distance and, thus, a long time of exposure in the desired environment for the products that are to be treated.

15 A further development of this concept is known from Applicant's own WO 99/57496 which relates to an apparatus for air treatment of foodstuffs with air or vapour. This apparatus comprises a conveyor belt of the type as described in the above-mentioned US 3,938,651. Due to the construction of the links and end closures in the stack, the stack is encapsulated in such a manner that a flow of air is passed through a central space defined by the

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helical path of the conveyor belt, and on to an annular space, which is defined by the construction of the conveyor belt and in which the foodstuffs are arranged. As the product moves through the stack, its parameters are changed, and consequently also the parameters of the air or water vapour. For instance cooling or heating of the product may be involved.

Additional processing steps are carried out in a conventional manner by the foodstuffs being conveyed through other apparatus for further treatment.

Thus apparatus for processing of foodstuffs in a separate step are previously known. Prior-art apparatus, however, do not allow continuous treatment in several steps in one and the same apparatus, such as boiling with subsequent drying and/or colouring.

#### OBJECT OF THE PRESENT INVENTION

The object of the present invention is to provide an apparatus and a method for treatment of foodstuffs with gaseous medium for processing and subsequent drying.

The apparatus and the method should allow integrated treatment, i.e. processing as well as subsequent drying to be performed in one and the same apparatus.

The apparatus should be simple in terms of construction and space-saving.

#### SUMMARY OF THE INVENTION

To achieve at least one of these objects and also other objects that will be evident from the following description, an apparatus and a method for treatment of foodstuffs with gaseous medium for processing and subsequent drying are provided according to the invention.

The term processing relates to treatment of foodstuffs by heating, for instance boiling or pasteurisation. Both packeted and non-packeted products can be treated.

The term drying relates to reduction of the water content of the products and primarily surface drying. The term drying may also comprise colouring of products, for instance a coating with egg and breadcrumbs.

5 As an example of fields of application, mention can be made of steam boiling of meat and pasta products or vegetables with subsequent surface drying before packet-  
ing. Another example is pasteurisation of bagged products such as ham and cheese. The apparatus can also be used to  
10 dry the surface of the bags immediately after processing before the subsequent labelling.

More specifically, an apparatus for treatment of foodstuffs for processing and subsequent drying is provided. The apparatus comprises an endless conveyor belt  
15 which along part of its length follows a helical path to form a stack, said helical path defining a central space in the stack, the conveyor belt having passages for letting a flow of a gaseous medium in the vertical as well as horizontal direction through the stack. The apparatus  
20 is characterised by an end portion of the stack, in which said stack is vertically surrounded by an encapsulation, a first means for supplying a first gaseous medium to said central space, and a second means for supplying a  
25 second gaseous medium to said encapsulation, said encapsulation being arranged to direct the flow of the second gaseous medium in such a manner that it is passed in the vertical direction from said encapsulation to the rest of the stack.

By arranging in this way an encapsulation of the  
30 stack, a division of the stack into two portions is obtained, which by the supply of the gaseous media allow treatment of foodstuffs in one and the same apparatus by both processing and subsequent drying. The length of the encapsulation as well as the height of the stack in combination with the conveying speed of the conveyor belt  
35 can be adjusted to the desired processing and drying respectively, i.e. the residence time in the non-

encapsulated portion and the encapsulated portion, respectively. The parameters of the gaseous media can be adjusted to the desired processing and drying, respectively. The apparatus is simple in terms of construction. Moreover, its vertical extent makes it space-saving. The apparatus is usable whether the conveyor belt is self-stacking or not.

In a preferred embodiment, the first gaseous medium is humid water vapour, while the second gaseous medium is overheated water vapour. The use of water vapour in different states is very advantageous in food technology since it does not add any foreign substances. It is also an inexpensive medium. The first gaseous medium may also consist of saturated water vapour.

It is preferred for the encapsulation to be arranged at the upper part of the stack. This position means in fact that the humid water vapour, which is heavier than the overheated water vapour, will move downwards in the stack. As a result, the products can, while being conveyed through the stack when they successively increase their degree of drying, be conducted up through the stack and, thus, away from the humid water vapour and water condensed therefrom. By thus using gravity, no outer driving source is required for the vapour to move through the stack.

In a preferred embodiment, a first end closure is arranged to cover the conveyor belt at the upper edge of the encapsulation. The first end closure forms a roof over the conveyor belt and is arranged to direct, together with the encapsulation, the flow of the overheated water vapour down through the encapsulated stack portion and on to the non-encapsulated stack portion.

It is further preferable that a second end closure be arranged over the central space. The second end closure forms a roof which helps to direct the flow of the supplied humid water vapour through the stack.

It is preferred that lateral pieces at a longitudinal edge of the conveyor belt form an outer wall of the stack, which defines the stack outwards in the radial direction. It is also preferred that lateral pieces at a longitudinal edge of the conveyor belt form an inner wall of the stack, which defines the stack inwards in the radial direction to define said central space. By thus letting lateral pieces at the edges of the conveyor belt form side walls, a division of the stack into a central space and an annular space is obtained. Thus, no separate wall portions are required to define the stack, which would obstruct the cleaning of the apparatus, which is crucial in foodstuffs handling.

It is preferred that a third end closure be arranged against the lowermost turn formed in the stack, said third end closure being arranged transversely of the central space defined by the conveyor belt. The third end closure forms a bottom in the stack and should be slightly conical so as to facilitate draining.

It is preferred that the means for supplying humid water vapour comprise a fan. The fan helps to press the humid water vapour into the annular space so as there to come into contact with the products. The fan also provides better circulation of the humid water vapour in the stack by slowly circulating the vapour and, thus, preventing layering, in which warmer water vapour with a higher moisture content would collect in the upper part of the stack.

The conveying direction of the conveyor belt is preferably towards the encapsulation. This means that the conveying direction is contrary to gravity and, thus, to the motion of the overheated and the humid water vapour moving downwards in the stack.

It is preferred for the stack to be arranged in a housing comprising an inlet and an outlet for the conveyor belt. It is also preferred for the housing to

comprise also a drain for draining off condensed water vapour.

In one embodiment the encapsulation has one outer and one inner circumferential wall having the same height, vertically surrounding a portion of the stack. In a second embodiment the encapsulation has one outer circumferential wall extending vertically along the full height of the stack, and one inner circumferential wall extending vertically along a portion of the stack, whereby said outer circumferential wall preferably has openings or perforations along the portion of the stack not covered by the inner circumferential wall. In a third possible embodiment the encapsulation has one outer and one inner circumferential wall extending along the full height of the stack, whereby both walls have openings or perforations along a portion of the stack.

According to another aspect, the invention relates to a method for treating foodstuffs for the purpose of processing and drying. The method comprises the following steps: providing an endless conveyor belt which along part of its length follows a helical path to form a stack, said conveyor belt having passages for letting a flow of a gaseous medium through the stack in the vertical as well as horizontal direction, the stack defining a central space, and the stack comprising a lower non-encapsulated stack portion and, adjacent thereto, an upper stack portion which is encapsulated in the vertical direction by an encapsulation, supplying a flow of a first gaseous medium to said central space for further conveyance to the non-encapsulated stack portion through said passages for letting through a flow of a first gaseous medium in the horizontal direction, supplying a flow of a second gaseous medium to said upper encapsulated stack portion, said encapsulation directing the flow of the second gaseous medium in such a manner that it flows in an essentially vertical direction from said encapsulated stack portion to said non-encapsulated stack

portion, and the flow of the second gaseous medium, which enters the encapsulated stack portion and flows essentially vertically downwards, affecting the flow of the first gaseous medium which is conveyed to the non-  
5 encapsulated stack portion so that the first gaseous medium is prevented from flowing towards the encapsulated stack portion.

#### DESCRIPTION OF DRAWINGS

10 The invention will now be described in more detail by way of example and with reference to the accompanying drawings.

Fig. 1 illustrates a self-stacking belt conveyor according to prior art.

15 Fig. 2 illustrates an apparatus for treatment of foodstuffs according to the present invention.

#### TECHNICAL DESCRIPTION

Fig. 1 illustrates a belt conveyor 1 according to  
20 prior art. The belt conveyor 1 comprises a conveyor belt 2 which, in the manner illustrated, is adapted to follow along part of its length a helical path comprising a number of successive turns 4 to form a stack 3. The shown conveyor belt 2 comprises a number of mutually articulated  
25 links 5 and can run straight, through curves upwards and downwards and also sideways.

The links 5 comprise a bottom part 6 and at least one lateral piece 7b which is arranged at the outer longitudinal edge of the conveyor belt 2. As shown, the  
30 links 5 may comprise one more lateral piece 7a at the inner longitudinal edge of the conveyor belt 2. The bottom part 6 constitutes a surface with some kind of perforation to allow water vapour to pass. The bottom part 6 may consist of, for instance, a mesh or a perforated metal sheet.  
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The links 5 are designed so as to allow a flow of water vapour both vertically and horizontally through the

conveyor belt 2. This occurs through passages which may consist of, for instance, the play between two successive links 5, two successive turns 4 in the stack 3 or holes formed in the lateral pieces 7a, 7b. The vertical flow is ensured by the perforated bottom parts 6.

The lateral pieces 7a, 7b of a first turn 4 in the stack 3 carry at least one longitudinal edge of a second turn 4' arranged on top of the first turn. This means that the conveyor belt 2 is self-stacking. The lateral pieces 7b at the outer longitudinal edge of the links 5 in the conveyor belt 2 thus form an outer cylindrical wall 8 of the stack 3 and, if there are lateral pieces 7a at the inner longitudinal edge of the links 5 in the conveyor belt 2, an inner cylindrical wall 9 of the stack 3. This results in an annular space 10 between the outer cylindrical wall 8 and the inner cylindrical wall 9. Furthermore a cylindrical central space 11 is defined by the inner cylindrical wall 9.

As an alternative to the inner cylindrical wall 9, the inner cylindrical wall may comprise a wall (not shown) which is separated from the conveyor belt, for instance a wall formed from the outer periphery of a drum that is used to carry the conveyor belt at its inner longitudinal edge in the stack. Consequently such a wall comprises the previously described passages to ensure a flow of water vapour in the horizontal direction from the central space and on to the annular space.

In both alternatives, the annular space 10 is used as a duct for a flow of water vapour over and round the products that are conveyed on the conveyor belt 2.

Water vapour normally flows vertically through the stack 3 and its annular 10 and central 11 space. Water vapour may also flow through the central space 11 in such a manner that it is forced horizontally through the above-described passages into the annular space 10 so as there to be conducted in the vertical direction between the turns 4, 4' included in the stack 3. This results



in a vertical as well as a horizontal flow through the stack.

Fig. 2 is a schematic cross-sectional view of an apparatus 15 according to the invention. The apparatus 15 is based on a belt conveyor 1 as described above. Therefore the description of its general construction will not be repeated.

The apparatus 15 comprises a first end closure 16 which is arranged to cover the annular space 10 of the stack 3. The apparatus 15 also comprises a second end closure 17 which is arranged to cover the central space 11 of the stack 3. The two end closures 16, 17 can be said to form a roof of the apparatus 15. It will be appreciated that the first and the second end closure 16, 17 can be integrated with each other and form a common end closure which in one piece covers both the annular 10 and the central 11 space. The two end closures 16, 17 should be easy to remove so as to allow access for maintenance and cleaning.

The apparatus 15 further comprises a third end closure 18 which is arranged at the lower edge of the stack 3 against the lowermost turn formed in the stack 3 in such a manner as to form a horizontal bottom wall which abuts against the inner cylindrical wall 9. The third end closure 18 is preferably slightly conical.

An end portion 19 of the stack 3, and more specifically its upper part, is along the outer 8 and the inner 9 cylindrical wall encapsulated in such a manner that the stack 3 is divided into an encapsulated stack portion 20 and a non-encapsulated stack portion 21. The encapsulation 22 is essentially tight in the horizontal direction. The upper edge of the encapsulation 22 fits tightly against the first end closure 16 and its lower edge fits tightly against the outer 8 and the inner 9 cylindrical wall. The term "fits tightly against" relates to a reasonable degree of sealing that prevents a considerable

flow of water vapour from passing. The necessary seal is established, for example, by means of a rubber strip.

The apparatus 15 is arranged in a housing 23. The housing 23 communicates with the environment through an inlet 24 and an outlet 25 arranged for the continuous conveyor belt 2. The conveyor belt 2 is thus allowed to pass through the inlet 24 and the outlet 25 to form its continuous path. Products are loaded and unloaded preferably outside the housing 23.

10 In the upper part of the central space 11 of the stack 3, a first means 26 is arranged to supply a flow of humid water vapour P1. In its simplest embodiment, the first means 26 consists of an inlet 27 that communicates with a fan 28. The means 26 is preferably arranged in the second end closure 17. The fan 28 is arranged to move the humid water vapour P1 through the stack 3.

15 In the upper part of the encapsulated stack portion 20, a second means 29 is arranged to supply a flow of overheated water vapour P2 through the encapsulated stack portion 20. In its simplest embodiment, the second means 29 consists of a tube 30 provided with a large number of orifices. The tube 30 extends through the annular space 10 between the first turn in the stack and the first end closure 16.

25 The overheated water vapour P2 is conducted through the encapsulated stack portion 20 and further down to the non-encapsulated stack portion 21 where it encounters the flow of the humid water vapour P1. The two flows P1 and P2 are combined in a common flow of humid water vapour P3.

30 The conveyor belt 2 has a conveying direction V towards the encapsulated stack portion 20, i.e. upwards in the stack 3 in the embodiment illustrated.

In the following the function of the apparatus 15 will be described. The products (not shown) adapted to be processed are placed on that part of the conveyor belt 2 which is arranged outside the housing 23. The products

are conveyed to the housing 23 and up through the stack 3 in the annular space 10.

5 The housing 23 including the central space 11 and the annular space 10 in the non-encapsulated stack portion 21 is filled with humid water vapour by the first means 26 for supplying humid water vapour P1. The central space 11 has been filled with humid water vapour by the water vapour being moved by means of the fan 28 into the annular space 10 through the previously described pas-  
10 sages in the conveyor belt 2. In the annular space 10, the humid water vapour will come into contact with the products and condense on them. Owing to the temperature difference in the housing 23, the humid water vapour moves towards a colder area, i.e. downwards through the  
15 annular space 10. Another driving force for the motion of the humid water vapour P1 downwards in the stack 3 is the flow of overheated water vapour P2, which will be described below.

Heating/boiling of the products for processing  
20 thereof occurs by means of the humid water vapour P1. The residence time, i.e. the processing time, of the products in the non-encapsulated stack portion 21 depends on the speed and the length of the conveyor belt 2 through this portion.

25 As the products are successively being conveyed up through the encapsulated stack portion 20, they are encountered by a flow of overheated water vapour P2. The overheated water vapour P2 moves downwards through the encapsulated portion 20 towards the non-encapsulated  
30 stack portion 21. In and in connection with the escaping from the non-encapsulated portion 21, the overheated water vapour P2 encounters more or less humid products as well as the humid water vapour P1, the overheated water vapour changing into humid water vapour and forming a  
35 common flow of humid water vapour P3.

As a result, the products on their way through the encapsulated stack portion 20 in the angular space 10

successively reduce their moist content on the surface, i.e. their surface dries up, before they finally leave the housing 23 through the outlet 25 formed therein for the conveyor belt 2. According to the degree of drying and the temperature of the overheated water vapour, also colouring of the products can take place.

As discussed above, the resulting moisture content depends on the residence time of the products in the encapsulated stack portion 20, but also on, for instance, the supplied flow of overheated water vapour P2.

It will be appreciated that during the process in the housing 23, water precipitates in liquid form. This is drained off from the housing 23 through a drain (not shown) in the third end closure 18. Water precipitated in the annular space 10 is suitably collected separately to be further drained off from the housing 23.

In the above described embodiment, the encapsulated stack portion 20 is arranged in the upper part of the stack 3. It will be appreciated that within the scope of the invention the encapsulated stack portion 20 can also be arranged in the lower part of the stack 3, in which case the conveyor belt 2 is driven in the opposite direction.

The encapsulation can be formed as one outer and one inner circumferential wall having the same height, vertically surrounding a portion of the stack. This is shown in fig 2. However, the encapsulation can also have other designs. By way of example, in one embodiment (not shown) the outer circumferential wall extends vertically along the full height of the stack, whereas the inner circumferential wall extends vertically along a portion of the stack. Such outer circumferential wall preferably has openings or perforations along the portion of the stack not covered by the inner circumferential wall. The encapsulation is thus essentially tight in the horizontal direction in the portion of the stack covered by the inner circumferential wall, and accordingly the

encapsulation is arranged to direct the flow of the second gaseous medium in such a manner that it is passed in the vertical direction from said encapsulation to the rest of the stack. The first gaseous medium is not  
5 prevented from flowing into the annular space of the stack.

In another embodiment, both the outer and inner circumferential walls of the encapsulation extend along the full height of the stack, and both walls have  
10 openings or perforations along a portion of the stack. Accordingly, the non perforated portion directs the flow of the second gaseous medium in such a manner that it is passed in the vertical direction from the non perforated portion of the encapsulation to the rest of the stack,  
15 while the perforated portion of the encapsulation allows a flow of the first gaseous medium through the openings/perforations and into the annular space of the stack.

To sum up, the present invention relates to an apparatus 15 and a method for treatment of foodstuffs with water vapour for processing and subsequent drying.

The apparatus 15 is based on a belt conveyor 1 comprising an endless conveyor belt 2 that follows a helical path to form a stack 3.

25 In the preferred embodiment, the stack 3 comprises an encapsulation 22 which vertically surrounds an upper portion of the stack. The conveyor belt 2 is designed so as to comprise lateral pieces 7a, 7b which form an outer cylindrical wall 8 and an inner cylindrical wall 9 which  
30 define the stack in the radial direction. The side walls 8, 9 define a central space 11 and an annular space 10, respectively, in the stack 3. In the central space 11, a first means 26 is arranged to supply a flow of humid water vapour P1. Due to the construction of the conveyor  
35 belt 2, this flow P1 is made to enter the annular space 10 where it comes into contact with the products conveyed on the conveyor belt 2 for processing. Furthermore a

flow of overheated water vapour P2 is supplied through the encapsulated stack portion 20. The encapsulation 22 directs the flow of the overheated water vapour P2 towards the non-encapsulated stack portion 21 where it comes into contact with the humid water vapour P1 and the humid products. The overheated water vapour P2 absorbs some of the moisture and is combined with humid water vapour P3 in a common flow. As a result, the products conveyed on the conveyor belt 2 successively reduce their moisture content while travelling through the encapsulated stack portion 20. The desired processing time and moisture content are controlled, inter alia, by the conveying speed and conveying distance of the conveyor belt 2 through the non-encapsulated stack portion 21 and the encapsulated stack portion 20, respectively. A further important factor is the relative humidity of the water vapour and the temperature of the overheated water vapour.

For controlling the temperature of the first gaseous medium, i.e. the humid water vapour, in the non-encapsulated portion 21, it is possible to supply the selected medium not only in gaseous form but also in liquid form. The supply occurs to the non-encapsulated stack portion 21. If the gaseous medium is, for instance, humid water vapour, it is thus possible to supply water in liquid form. The liquid is supplied atomised through nozzles (not shown). The technique is used in the first place if the temperature in the non-encapsulated portion 21 should be too high. Thus the supply does not occur continuously, but temporarily when required.

The apparatus has been described above based on a belt conveyor with a self-stacking conveyor belt. It will be appreciated that the invention can be applied with the same result to a belt conveyor comprising a non-self-stacking conveyor belt.

It will also be appreciated that the apparatus and the method with minor modifications can also be used for

drying only. Then the drying can take place in two steps. In this case, the first gaseous medium and the second gaseous medium consist of the same substance, preferably overheated water vapour. However, the two media are given  
5 different temperatures.

The above description has been based on use of a first gaseous medium in the form of humid water vapour. In the same successful way, the first gaseous medium may consist of saturated water vapour.

10 According to the invention, an apparatus and a method for treatment of foodstuffs with water vapour for processing and subsequent drying are provided. The processing and the subsequent drying are integrated so as to be carried out in one and the same apparatus while  
15 the products are conveyed on a conveyor belt through the apparatus. The apparatus is space-saving and also simple in terms of construction.

It will be appreciated that the present invention is not limited to the shown and described embodiment of  
20 the inventive apparatus and method. Several modifications and variants are thus conceivable, and consequently the invention is defined exclusively by the appended claims.